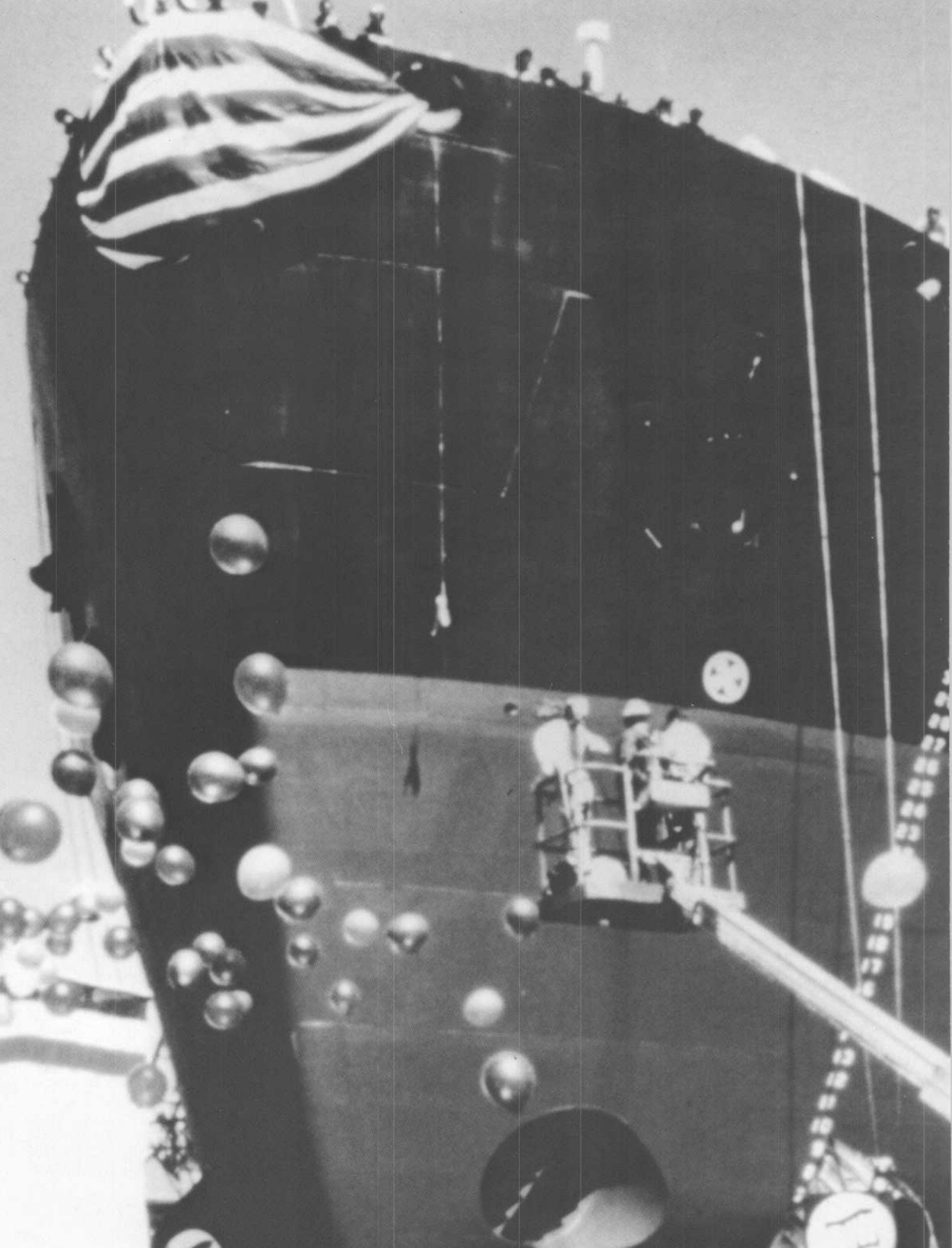
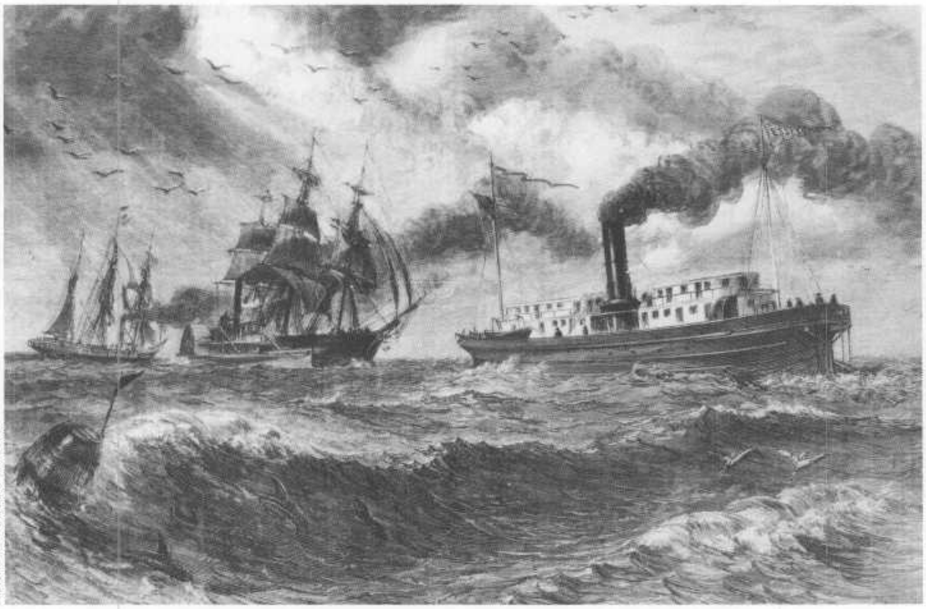


Waterway Development



Historic New Orleans Collection

The first Corps of Engineers' dredge *Essayons* at the mouth of the Mississippi, c. 1870.

National Archives

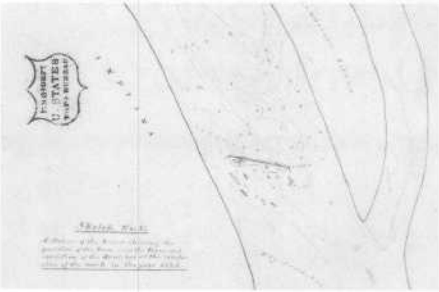
Excavating the Illinois and Mississippi Canal, 1904.

Portland District files, Corps of Engineers

Launching the new dredge *Essayons*, 1982.

Benjamin Henry Latrobe, a famous early 19th century engineer, once remarked that "nothing is so easily converted to a civil use, as the science common both to the profession of a civil and military engineer." Few of Latrobe's contemporaries questioned this observation; engineers were also scientists and navigation improvements required a scientific approach utilizing principles developed mainly in Europe. At West Point, Army engineers learned the principles and applied them in their surveys of navigable rivers, often making their own significant contributions to river hydraulics in the process. In the early 1820s, Corps of Engineers officers surveyed both the Ohio and lower Mississippi rivers. In the succeeding years many more rivers were investigated. Many early navigation improvements resulted from trial and error, however, rather than from strict adherence to theory. If the obvious did not work, the less obvious was used, until some method seemed to produce the desired result. A good example is the work on the Ohio River.

In 1824 Chief Engineer Alexander Macomb dispatched Major Stephen H. Long to the Ohio to initiate experiments to provide safer navigation. The major challenge was to deepen channels across sand and gravel bars. Long decided to perform experiments on a compacted gravel bar near Henderson, Kentucky, just below the mouth of



Sketch showing position of dam and sandbar on the Ohio, 1825.

National Archives

Office of History, Corps of Engineers

Brevet Major General Gouverneur K. Warren.

the Green River. At low river stage, this bar was covered by only 15 inches of water. After preliminary studies, the major outfitted several flatboats with hand-powered pile drivers and began to build a wing dam, so-called because the structure extended from the bank of the river at a 45 degree angle. The dams decreased the width of the channel, thereby increasing the current's velocity. Theoretically, this would cause the river to scour a deeper channel. Long built the dam to various widths, lengths and heights. The final structure was 402 yards long and consisted of twin rows of 1,400 piles joined with stringers and filled with brush. Sediment gathered against the dam and helped anchor it to the riverbed. The project's total cost was $3,378.93.

Wing dams such as Long's were used on the Ohio and other major rivers during most of the 19th century, but their effectiveness was always marginal. They were easily destroyed and did not always produce the desired results. After the Civil War, Corps officers grew increasingly skeptical about the dams. Brevet Major General Gouverneur K. Warren, a well-respected engineer officer, candidly wrote in 1867, "I do not believe the country will ever stand such a heavy continuous outlay as the wing-dam system of the Ohio has caused, and I believe that the extravagant and useless expenditure there, in the palmy days of western river improvements between 1830 and 1844, did more than anything else to bring the whole subject into disrepute."

Warren's pessimism was unjustified, for both Congress and commercial interests continued to support waterway improvements after the Civil War. Indeed, the support increased. Rivers and harbors work jumped from about $3.5 million for 49 projects and 26 surveys in 1866 to nearly $19 million for 371 projects and 135 surveys in 1882. Nevertheless, Warren's frustration was shared by other engineers. W. Milnor Roberts, a well-known civil engineer, concluded in 1870 that existing navigation facilities on the Ohio, while certainly of public benefit, were no better than an "amelioration of the present difficulty." He proposed instead to canalize the river through the construction of 66 locks and dams. This project would offer six-foot slackwater navigation from Pittsburgh, Pennsylvania, to Cairo, Illinois.

Chief of Engineers Andrew A. Humphreys organized an Army Engineer Board of Inquiry, composed of Majors William E. Merrill and Godfrey Weitzel, to examine the question of canalizing the Ohio. The

Public Affairs Office, Corps of Engineers.

Ladder bucket dredge at work.

Steamboats line the St. Louis waterfront, 1909.

National Archives

Lt. Eugene A. Woodruff: "A Model for all Similar Undertakings . . ."

In 1873 Captain Charles W. Howell, district engineer at New Orleans, assigned his deputy, Lieutenant Eugene A. Woodruff, to the Red River of Louisiana as supervisor of the project to clear the river of the great log raft, a formidable obstruction to navigation. In September of that year Lieutenant Woodruff left his workboats and crew on the Red River to visit Shreveport and recruit a survey party. When he arrived, he found Shreveport in the grip of a yellow fever epidemic. Fearing that he might carry the disease to his workmen if he returned to camp, Woodruff elected to remain in Shreveport and tend to the sick. Volunteering his services to the Howard Association, a Louisiana disaster relief charity, he traveled from house to house in his carriage, delivering food, medicine, and good cheer to the sick and dying. He contracted the disease and died of it in Shreveport on September 30.

"He died because too brave to abandon his post even in the face of a fearful pestilence and too humane to let his fellow beings perish without giving all the aid in his power to save them. His name should be cherished, not only by his many personal friends, but by the Army, as of one who lived purely, labored faithfully, and died in the path of duty. . . . His conduct of the great work on which he was engaged at the time of his death will be a model for all similar undertakings and the completion of the work a monument to his memory," wrote Captain Howell.

Howell then assigned the task of completing the work on the Red River to Assistant Engineer George Woodruff, the lieutenant's brother. On November 27, 1873, the Engineers broke through the raft, finally clearing the Red River for navigation.

officers agreed with Roberts that a system of locks and dams would best provide for future navigation. Somewhat surprisingly, the recommendation met resistance from the very group which would most profit from its implementation. Coal shippers, in Merrill's words, were "absolutely opposed to a slack-water system, unless arrangements can be made to pass their fleets through without stopping and separating for the passage of locks."

The resistance forced Merrill, who was in charge of Ohio River improvements, to look for alternative solutions. He thought the wicket dam design developed by Jacques Chanoine in France in 1852 might be adapted for use on the Ohio. The structure utilized a number of large folding boards, called wickets, which were hinged to a concrete base at the bottom of the river. Each wicket was about 3-3/4 feet wide and 12 feet long. When the wickets were raised, the water behind them rose high enough to insure navigation. During high water they could be lowered to allow boats to pass unimpeded. In this way, the delays the coal shippers feared would be avoided.

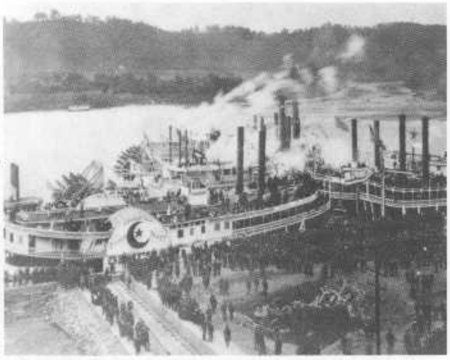
In 1874 Merrill proposed that a series of movable dams, employing Chanoine wickets, be constructed on the Ohio. For the first step, he recommended that a 110 by 600-foot lock and movable dam be built at Davis Island, five miles below Pittsburgh. In 1877 Congress approved Merrill's plan. A year later, the

U.S. Military Academy Library

Log raft on the Red River.

Placing bank protection along the Arkansas River near Pine Bluff, 1881.

National Archives



The Davis Island Lock dedication, October 7, 1885.

Public Affairs Office, Corps of Engineers

Corps began construction of the Davis Island project, completing it seven years later. The 110 by 600-foot lock was the largest in the world, as was the 1,223-foot-long dam. The dam was actually composed of 305 separate Chanoine wickets and three weirs.

Impressed by the early success of the Davis Island project, in 1888 Congress authorized the extension of the six-foot navigation project down the Ohio. By 1904 two locks and dams had been completed, seven were under construction and five more were funded. At this time, before further work was done, Chief of Engineers Alexander Mackenzie decided to conduct another complete review of the project. The basic question was whether the project should be extended down the lower Ohio River, particularly in view of generally declining commerce on inland waterways.

Pursuant to congressional authorization, Mackenzie appointed a board headed by Colonel Daniel W. Lockwood and therefore called the Lockwood Board. Its review of the Ohio River project led to recommendations for a nine-foot project for the entire course of the Ohio. This conclusion rested on the finding that the probable cost per ton-mile for a six-foot project would be nearly fifty percent greater than for the nine-foot project. In the 1910 Rivers and Harbors Act, Congress authorized the construction of a nine-foot Ohio River canalization project. At a cost of about $125 million, the project was completed in 1929.

Meanwhile, the Corps had been busy in other parts of the country developing a reliable internal waterway system. One of the key projects, going back to the mid-19th century, was the Soo Locks at Sault St. Marie, Michigan. These locks were instrumental in securing a navigable route from the copper and iron mines on the shores of Lake Superior to the industrial plants of the East. In 1852 Congress agreed to help private interests finance the cost of building a canal at St. Marys Falls to replace a structure on the Canadian side that had been destroyed during the War of 1812. Congressional participation involved granting 750,000 acres of land to the state of Michigan. Captain August Canfield of the topographical engineers was assigned as chief engineer and superintendent of the project for the state of Michigan. Canfield's design for the canal conformed to the congressional stipulation that the passage should be not less than 100 feet in width and 12 feet deep, with two locks not less than 250 feet long and 60 feet wide.

Within two decades, burgeoning traffic and larger vessels made the original canal inadequate to serve commercial needs, so Congress authorized the deepening of the St. Marys River channel and the construction of a new facility—the Weitzel Lock. Corps work began on July 11, 1870, with the appropriation of $150,000. The original canal was widened, varying from 50 to 108 feet, the depth increased from 12 to 16 feet, and the Corps constructed a lock 515 feet long by 80 feet wide with a lift of 17 feet.

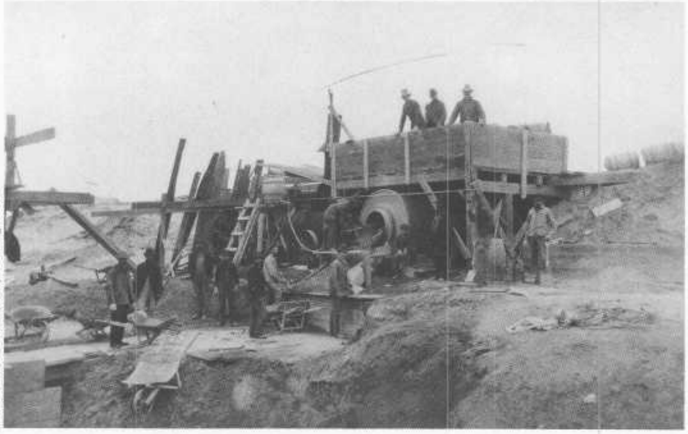
At the time of its construction, the Weitzel Lock was considered to be the latest in lock technology. Its culvert valves, of the butterfly type, were operated by a single stroke hydraulic engine directly connected to the valves. Hydraulic turbines generated the power which operated the lock gates. A movable dam was also introduced to shut off the flow of water during maintenance operations.

The Army's success in providing a passage to Lake Superior and Canada's commitment to canal building whetted the desires of shippers and industrialists for a deep water route through the Great Lakes—a dream eventually realized in the 20th century with the completion of the St. Lawrence Seaway.

It was the turn of the century when Congress responded to the renewed interest in water transportation by authorizing navigation projects designed to create an integrated system connecting inland areas with coastal harbors. Sandbars and rapids along the Ohio, Missouri, Arkansas and other major rivers posed major obstacles to the maintenance of year-round navigation channels. Eventually, with the advancement of lock and dam technology and more efficient dredging equipment, a nine-foot channel depth was assured in the Mississippi and its major tributaries.

Corps of Engineers navigation projects continue to play an important role in support of America's economic well-being. Commercial use of the 12,000 miles of inland and intracoastal waterways has increased: approximately one-sixth of all intercity cargo is transported by water. Waterborne commerce, recognized by experts to be the least expensive and least energy-consumptive means of transportation, is the logical choice for shippers of energy-producing commodities. Petroleum and coal together comprise more than half of all waterborne freight on the federally maintained waterways.

This expansion has been facilitated by the Corps' work on major waterways, including locks and dams. The Corps dredges more


Public Affairs Office, Corps of Engineers

Mixing plant on the Illinois and Mississippi Canal, 1900.

than 300 million cubic yards of material annually in order to maintain authorized channel depths and constructs bank stabilization projects in its traditional role as the primary developer of the nation's waterways. Also, as of 1996, engineer districts and divisions owned or operated 275 lock chambers at 230 sites. The oldest operating locks are Locks 1 and 2, which were built on the Kentucky River in 1839. The nation's newest locks opened in December 1994 and included the Joe D. Waggoner Lock and the Russell B. Long Lock on the Red River. An efficient system of interconnected waterways has proven to be a key factor in America's ability to mobilize in the event of war.

Engineer as Steamboat Designer

Colonel Stephen H. Long, an engineer officer famous for his exploration of the American West and for the survey and construction of early American railroads, also designed his own steamboat. In 1818, Long planned the building of the experimental craft, the *Western Engineer*, to transport himself and a task force of scientists, naturalists and artists as far west as possible by water on their projected trip into the frontier. The result was a steamboat designed to navigate narrow, shallow, snag-littered channels of inland rivers. It contained a particularly strong engine to provide increased power for pushing against swift currents. Another novel feature was a paddlewheel built into the stern to reduce the danger of damage from snags. The boat had a 75 by 13-foot hull with the weight of the machinery carefully distributed to permit increased maneuverability in shallow channels.

Altogether the *Western Engineer* was anything but a typical steamer. In fact, when launched in May 1819, its appearance was fearful—"Huge, black, scaly, the gigantic serpent blasted steam from its gaping mouth as it thrashed down the Ohio River, white foam dashing violently behind." In order to protect the vessel from Indian attack, Long installed a bulletproof pilot house. In addition, he had a cannon mounted on the bow, placed howitzers along the sides, and armed the crew with rifles and sabres. The boat had a serpent-like shape to frighten any would-be attackers.

The *Western Engineer*, drawing but 19 inches of water compared to the five or six feet of most steamboats, became the prototype of the western river steam vessels. In it, Long and his crew explored the Ohio River and ascended the Mississippi and Missouri rivers into Nebraska. On his journey, Long's *Western Engineer* traveled farther west than any other steamboat.


Office of History, Corps of Engineers

Soo Locks.